NASA MAGAZINE

fall 199

from the administrator

"One need only look at the expressions of the children on the cover of this magazine to realize that the space program can play a unique role in capturing the imaginations of our young people. Our programs have the potential to inspire them to study and pursue careers in science, engineering and related fields."

I'm happy to have this opportunity to introduce the first issue of *NASA Magazine*.

We have such a diverse agency, with so many fascinating projects underway, sometimes it's hard to keep track of them all. My hope is that *NASA Magazine* will help make all of us more aware of each other's business, since an important part of any good Total Quality Management program is communication within the organization.

I'm especially pleased that the first issue focuses on education. Since its founding, the agency has been involved in education programs, seeking to capitalize on the instinctive interest of young people in airplanes, spacecraft, and exploration. The cover story is but a sampling of education programs throughout NASA, reaching students at every level.

Mindful that the children in today's classrooms are tomorrow's scientists, engineers, and colonists on the Moon—and beyond—we have a vested interest in doing our part to help the nation reach its goal of being first in math and science. I am proud of what this agency is doing to enhance education, and I look forward to working with our new Associate Administrator for Human Resources and Education, Lieutenant General Spence (Sam) Armstrong, to make a good program even better.

NASA is faced with an unprecedented range of exciting challenges.

We can only imagine the technologies that will allow humans to live and work permanently in space. A well-educated and technologically literate population is essential if we are to realize our dreams and remain the premiere space-faring nation in the world. One need only look at the expressions of the children on the cover of this magazine to realize that the space program can play a unique role in capturing the imaginations of our young people. Our programs have the potential to inspire them to study and pursue careers in science, engineering and related fields.

While our cover story focuses on efforts to make a difference in education, our "As I See It" feature delivers a strong message about the difference education can make. I invite you to read these and all of the interesting stories presented in this first issue of our exciting new quarterly publication. And I look forward to sharing my thoughts with you in this column in each upcoming issue.

Richard H. Truly

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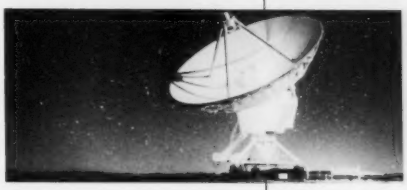

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NASA MAGAZINE is published quarterly by the National Aeronautics and Space Administration for the information of the Agency's employees. Contributions and comments are solicited from Headquarters and all field centers, and should be addressed to Editor, NASA MAGAZINE, Internal Communications, Code P-2, NASA Headquarters, Washington, DC 20546.

Firefighters to Benefit

The Ames Research Center and Terra-Mar Resource Information Services, Inc., of Mountain View, California, will jointly develop a system to allow firefighters to merge elevation and vegetation data with live aircraft pictures of forest fires. This will enable firefighters to see through a smoky forest fire and plan their firefighting strategy better.

Space Station Restructured; KSC Gets Ready

NASA has submitted a restructured Space Station Freedom plan to Congress. The new plan calls for assembly of Freedom beginning in mid-1996, with a man-tended capability in late 1998. The plan also calls for a four-person, permanently manned capability in 2000. Meanwhile, the Kennedy Space Center has awarded a $521.5 million contract to Metric Constructors, Inc., of Tampa, for construction of the KSC Space Station Processing Facility. The new building will be a 457,000-square-foot, three-story multifunction facility housing laboratories, control rooms, staging areas, communications and control facilities, and office space.

NASA South Pole Connection Gets Stronger

NASA and the National Science Foundation have signed an agreement allowing NASA scientists to use the Antarctic to conduct basic scientific and technical research, which could be directly applicable to the development of a moon base or Mars journey. The first NASA/NSF-sponsored research activity is expected to occur this winter (summer in the Antarctic) when Ames Research Center biologists continue their ongoing exploration of dry moraine valley frozen lakes.

Space Garden Harvest Continues at Two Centers

Johnson Space Center harvested their second crop of green lettuce from a special chamber outfitted with regenerative life support systems in May. The lettuce was grown in an array of nearly 500 special receptacles containing a solid medium automatically bathed with a nutrient solution. Meanwhile, Kennedy Space Center researchers have harvested their third crop of soybeans grown in the Closed Environmental Life Support System, another special facility equipped with regenerative life support systems. Both centers are providing basic research that will help determine habitability requirements and capabilities for lunar and Martian bases.

Shuttle Delivery Follows 10-Year Flight Anniversary

On April 12, NASA observed the tenth anniversary of the first flight of the Space Shuttle. This was followed 13 days later by the rollout of the new orbiter Endeavour in a ceremony at Rockwell's Space Systems Division plant in Palmdale, California. NASA's newest spaceship, known as OV-105, features a host of enhanced systems and improved or updated components, including a drag chute, intended to slow the ship on landing.

LDEF Scientists Announce Discovery of Beryllium-7

Several Long Duration Exposure Facility investigators have reported finding the rare atmospheric isotope Beryllium-7 on the surface of the Long Duration Exposure Facility recovered in 1990 after nearly six years in space. The isotope is radioactive and is produced naturally by cosmic ray reactions in Earth's atmosphere. Beryllium-7 has been studied as a means of tracing the distribution and transport of atmospheric gases in the lower atmosphere. The isotope is mainly produced at much lower altitudes than the178-mile altitude where LDEF was orbiting, and these new findings show that some as-yet-undetermined process efficiently carries it to high altitudes.

More Dinosaur Extinction Evidence Found

NASA researchers have found the first surface evidence of what could be a buried crater formed by the impact of the comet or asteroid that may have caused the extinction of the dinosaurs. Charles Duller of Ames Research Center, along with Kevin Pope of Geo Eco Arc Research in La Canada, California, and Adriana Ocampo of the Jet Propulsion Laboratory, made the announcement on May 10. The trio made the discovery while searching through 1987 satellite imagery of Mexico's Yucatan area for water sources used by ancient Mayan cities. The team was able to piece together the impact crater evidence from a ring of sink holes more than 125 miles in diameter. A core sample taken from nearby exploratory oil wells and analyzed by Pope and Ocampo showed the floor of the crater dates back 65 million years to the late Cretaceous period. The boundary between the late Cretaceous and the subsequent Tertiary period coincides with the demise of the dinosaurs, and also shows enriched deposits of iridium--a metal more abundant in comets and asteroids than in Earth's crust--suggesting that an asteroid struck the Earth 65 million years ago.

Magellan Data Ripe for Assessment; Names Sought

The Magellan radar-mapping spacecraft completed one Venus mapping cycle on May 20 and began a series of scans designed to provide three-dimensional radar views of the surface. The first cycle's data is providing Magellan planetary scientists with enough information to begin testing competing theories concerning the nature of the continent-sized highland region on Venus, Aphrodite Terra. The public has been invited to propose names of notable women for the many impact craters and large volcanic vents discovered by Magellan.

Hubble Completes One Year

The Hubble Space Telescope completed one year of operation on April 26, having accomplished a significant set of observations while scientists have finalized plans to compensate for the spherical aberration in the telescope's main mirror by modifying replacement instruments. Among Hubble's recent discoveries are globular clusters with hundreds of "blue straggler" stars, now confirmed to have been reborn red giant stars. Replacement inertial measurement gyroscopes also will be flown on the repair mission scheduled for 1993, as will replacement solar panels.

Highways to Benefit from NASA Commercial Center

One of NASA's 16 Centers for the Commercial Development of Space, the Ohio State University Center for Mapping, located in Columbus, has developed a system that reduces the time needed to gather highway condition information. Unreported deteriorating road conditions are believed to cost the taxpayer $16 billion a year in wasted fuel and excessive vehicle repair charges. The Ohio State system uses a vehicle equipped with TV cameras and Global Positioning System (GPS) equipment that automatically maps and records the condition of bridges, railways, grass-mowing areas, equipment locations and secondary roads.

TRANSITION

Died

Paul F. Bikle, director of the then Flight Research Center (now Ames-Dryden Flight Research Facility) from 1959 to 1971, died January 19 in Salinas, California. All 199 X-15 spaceplane flights were conducted under his directorship.

James B. Irwin, the eighth human to walk on the moon, died August 8 at the age of 61. Irwin was the Lunar Module pilot for Apollo 15 and piloted the Falcon to a landing at Hadley Rille on July 30, 1971. Irwin and David Scott explored the area using a Lunar Rover.

Honored

Dale L. Compton, Ames Research Center Director, elected to the Silicon Valley Engineering Council's Hall of Fame.

Leo Monford, named the 1990 NASA Inventor of the Year for his Docking Alignment System.

General Elmer Brooks, Deputy Associate Administrator, Management, named a distinguished alumnus by George Washington University.

The Astronauts Memorial, honoring the 16 U.S. astronauts who have given their lives in the line of duty, was dedicated May 8 at a quiet lagoon near the Kennedy Spaceport USA Visitors Center.

Changing Jobs

Michael Griffin, named Associate Administrator, Office of Exploration. He was most recently the director of technology for Space Defense Initiative Program.

Lt. Gen. Sam Armstrong, named Associate Administrator, Office of Human Resources and Education. Recently a member of the Synthesis Group, he was commandant of the Air Force Training School, San Antonio, Texas.

James D. Bain, named director of the newly created Systems Analysis and Concepts Office at Headquarters.

Dr. William F. Fisher, M.D., resigned from the astronaut corps to return to a full-time medical career at the Humana Hospital-Clear Lake, near Johnson Space Center.

Col. Guy S. Gardner, named Commandant of the USAF Test Pilot School at Edwards Air Force Base. He resigned from the astronaut corps to assume his new position.

Lawrence J. DeLucas, University of Alabama, Birmingham, and **Eugene H. Trinh**, Jet Propulsion Laboratory, selected as payload specialists for the first U.S. Microgravity Lab Shuttle mission, in 1992.

Mary Cleave, resigned as astronaut to become deputy project manager for the Goddard Space Flight Center SeaWiFs project, a joint NASA and commercial venture. ●

Aircraft Emergency Flight Control System To Be Tested

Dryden Flight Research Facility studies show that multi-engine aircraft that experience massive hydraulic failure can still be brought to a safe landing using only the plane's engines for flight control. Dryden is working with a simulator programmed to look at engine-only handling of flight control requirements. The system uses an augmented flight control system, which takes pilot stick inputs and converts them into commands that control each engine's thrust differently. This system has tremendous safety potential for commercial multi-engine aircraft. ●

Her Majesty Queen Elizabeth II, His Royal Highness Prince Phillip and their party visited the Johnson Space Center in May as part of Her Majesty's tour of the United States at the invitation of President Bush.

This is not the same Congress that approved the Apollo program, nor even the Space Shuttle. Gramm-Rudman has changed the political climate, which may require some adjustments to NASA's thinking in the '90s.

This Ain't Apollo Anymore

by John Lawrence,
Office of Legislative Affairs,
NASA Hq.

A new phrase has entered Capitol Hill's vernacular: "Big Science." It's a fair description of some of the nation's more ambitious undertakings, including the Superconducting Super Collider, the Human Genome Project and Space Station Freedom. Regrettably, however, the phrase is frequently used disparagingly, as in, "We can no longer afford Big Science."

Can this be the same Congress that supported the Apollo program, the federal laboratory system and the development of nuclear energy in earlier eras? Clearly, a radical shift has occurred in the way the legislative branch regards science and technology.

There are several reasons for this shift, and they are worth understanding. First is the climate in which the budget evolves. Concern with the federal deficit now covers the fiscal landscape like a blanket. The Gramm-Rudman-Hollings Deficit Reduction Act of 1986 essentially mandates a no-growth federal budget, with built-in penalties when target dates are not met. Additionally, the Administration and Congress entered last year into a five-year agreement called the Omnibus Budget Reconciliation Act, which leaves even less flexibility. It established specific caps for discretionary spending in three separate accounts: defense, international and domestic programs. The latter includes NASA and all domestic programs from veteran's affairs to transportation.

The budget is shaped by spending resolutions, by the actions of Budget Committees, and by specific allocations to each Appropriations Subcommittee. These checks effectively reduce Congress' flexibility to start or support new initiatives, which creates a status quo mindset—be happy if you get the same level of funding as last year's. Unfortunately, such thinking wreaks havoc on capital-intensive projects with long lead times, such as NASA's.

As the process has changed, so has the makeup of the Congress. In the House of Representatives, nearly 40 percent of the members have taken office since 1985. Nearly 65 percent have been elected since 1981. This is not the same institution that supported the Apollo program, nor even that approved the Space Shuttle. This Congress' view of NASA has been shaped more by the Challenger accident and Hubble Space Telescope problems than by the lunar landing.

In the 1990 election, there was a 10 percent turnover in the House membership, and many other incumbents had uncomfortably close races. Most new members describe themselves as fiscal conservatives and lament over "tough choices to make" in the budget process. Odds are, 1992 could see another big turnover in the House membership in the wake of Congressional redistricting.

Finally, there is the problem of technology itself. As "Big Science" becomes more complex, it becomes more difficult to understand. It's the age-old disconnect between the scientist and the layperson, exacerbated by the increasingly specialized and esoteric nature of science. Some social scientists believe there may even be a cultural bias against science dating back to Mary Shelley's "Frankenstein."

The space program has a rich tradition of innovation and technology transfer to the private sector. Spinoffs from the space program are all around us in today's marketplace. NASA projects now in development surely will produce the same economic fallout, but they cannot be foreseen with specific accuracy. Consequently, when bottom-line-oriented legislators are told that prosperity will result from Space Station Freedom, they may be skeptical in the absence of specifics. It is therefore our responsibility to make the case for long-term investments.

The outlook is not entirely bleak. Many members of Congress support NASA, have a sophisticated understanding of its programs and a visionary sense of the future. NASA programs are healthy, but the future outlook is severely constrained.

It is important, therefore, to recognize the increasingly difficult and complicated environment on Capitol Hill. These new circumstances mean we must work harder to make ourselves understood and appreciated, and continue to bolster our credibility with programs that work as advertised. ●

Jill Noble has a handicap, but it doesn't seem to slow her down, on or off the job. Ask the many Cleveland area citizens whom this Lewis Research Center employee has helped to lead more active and fulfilling lives.

Jill Noble's workday starts at the Lewis Research Center, but it rarely ends there. After hours you might find her speaking at a Kiwanis Club meeting, or swimming laps to raise funds for the local diabetes association, or at a local theater production, supporting efforts to provide scenic narration for the blind.

Noble Pursuits

by Les Reinertson, Hq.

Jill Noble was born sightless, but her handicap has never kept her from being busy. Maybe it's her independent streak.

"I left home for Cleveland State University when I was 19," she says. "My parents thought it best that I learn to be self-sufficient as soon as possible."

While working on a computer science degree—she'll graduate shortly, after 10 years of working her way through the University—she also worked at Lewis as a student intern.

Not content with purely academic pursuits, Noble became an activist for the sight-impaired and other people with handicaps. At the Cleveland Sight Center, she served during her years at the University as a social coordinator, helping the blind learn everyday living skills including shopping at the supermarket, eating out at restaurants, using public transportation and even playing putt-putt golf. Noble's work at the Sight Center has also included helping pre-college students cope with problems from textbook selection to locating handicapped services.

Back at Lewis, Noble is involved in her office's efforts to provide a systems management program for the center's security department. A bus commuter herself, Noble explains, "It's a system designed to help keep track of violations—mostly parking violations!"

As a member of the NASA speakers bureau, she finds herself facing all kinds of audiences. In an elementary school classroom, the subject may wander from "How big is the Space Shuttle?" to "Why is that dog (Gresham, her trusty Labrador guide dog) here?" Even when the subject is the space program, most audiences are interested in how Noble deals with her own handicap. "That's a big part of why I like to get out into the community—to explain how blind people are part of the community, and how it's a person's attitude, not his disability, that is important."

Noble makes a point to arrive at most of her speaking engagements by bus. That way she can show student audiences what skills the blind must develop to be independent: using a transportation system, for example, or overcoming architectural barriers.

Noble's understanding of handicapped issues has been recognized by state officials. She served four years on the Governor of Ohio's Council on Advocacy for Disabled Persons, and has also served on a consumer advisory panel for the Library of Congress concerning services for the blind.

When Noble's work day is done, after she's talked to the Cub Scouts and Girl Scouts and put in her time as treasurer for the Cleveland chapter of the American Council of the Blind, she still finds time for herself.

"I admit it," she says, "I'm a dyed-in-the-wool "Jeopardy" fanatic." But then she adds, "You know, maybe a braille theater newsletter would help involve more people in the community." ●

With technology borrowed from wind tunnel testing, new fetal heartbeat monitors help keep tabs on expectant mothers, even when the doctor is far away.

Mother and Baby Are Doing Fine!

by Les Dorr, Jr., Hq.

It's a magic moment when expectant parents hear the rapid, rhythmic lub-dup, lub-dup of a healthy baby's heartbeat for the first time. It's also a welcome assurance that all is well with the developing life inside the mother's womb.

But there are some women who never get that encouragement. For various reasons, they don't receive adequate prenatal care from a physician. With NASA's help, Montana physician Donald Baker is doing something about the situation.

From his work with expectant mothers on a Native American reservation, Baker realized how difficult it was to keep tabs on a baby's condition when the nearest doctor's office or hospital was many miles away. Knowing that the fetal heartbeat is a proven barometer of a baby's health, he had an idea: Why not fit mothers-to-be with a small, wearable device that would continuously monitor the heartbeat and alleviate the need for in-office medical care?

Trouble was, such an instrument didn't exist. The available fetal heart monitors, which use ultrasound, were bulky and highly sensitive to abdominal position. They also needed a trained technician to operate them.

Baker developed a preliminary design for a portable monitor and even patented the concept. But when he tried to find someone to develop and market it, he was told the technology was out-of-date and the device was still too cumbersome for practical use.

To get the most advanced technology possible, Baker asked NASA's Office of Commercial Programs at Headquarters for advice. In 1987, the Langley Research Center was assigned to review Baker's ideas. "We thought the concept was sound, but could benefit from lighter-weight equipment," recalls Frank Farmer, Langley's manager of Applications Technology Programs. "We recommended that Commercial Programs pursue it as a project."

After they got the go-ahead in 1987, a team of experts headed by Allan Zuckerwar of Langley's Technology Utilization Office started to improve Baker's fetal monitor. Zuckerwar decided that passive, film-type acoustic sensors—normally used at Langley to measure pressures on aircraft and wind tunnel models—might fit the bill.

His device makes use of a center sensor surrounded by six more sensors in a circle. Besides detecting the heart pulses from the fetus, the design also cancels signals due to the mother's body motion and shields against electronic interference.

The gee-whiz brain of the monitor is a tiny computer that runs on software developed by engineers at Virginia's Old Dominion University. The computer selects which of the seven sensors is receiving the strongest fetal heart tones, then distinguishes in real-time between normal signals and those that don't fit preprogrammed "ideal" parameters.

The Langley researchers built a non-portable prototype and tested it on volunteer mothers at Eastern Virginia Medical Center in Norfolk, where it went head-to-head against the "industry standard" ultrasonic monitors. The result: The prototype yielded almost the same quality of information as its larger, stationary competitors.

A refined model of the portable fetal heart monitor is being sent to Baker in Montana. Farmer notes that there is already some private interest in marketing the instrument and the U.S. Bureau of Indian Affairs may fund its manufacture on a reservation.

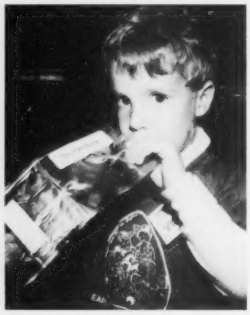
"We think it's the ultimate in safe monitoring devices," says Farmer. "It doesn't project energy into the mother's body because it's a passive listening instrument. And it gives the same data that a doctor would get in his office or at the hospital." ●

Reading, W
ROC
See NASA laun

The seventh grader shifts restlessly, his eyes straying to the back of the room. Like a horse at the starting gate, he makes a beeline for his goal as soon as the class is released. Should he first test his eye-hand coordination? Manual dexterity? Peripheral vision? Maybe he should try on the spacesuit before demonstrating Newton's Third Law of Motion on the rotating chairs.

So much to do, so many experiments to try.

A few minutes later, he's sitting with a rapt group of students, listening to Aerospace Education Specialist Jerry McCoy describe the speed of the Space Shuttle, "If we were going on the Shuttle, we could be at Disneyland in 12 minutes." McCoy pauses for effect. "That's Disneyland in California," he adds, amid astonished murmurs. "We would be traveling at a speed of about 17,500 miles an hour."



Four-year-old Byron Kerr samples an orange drink package designed for astronauts during a visit to Stennis Space Center's Early Education Monday program.

Here at Kennedy Space Center's Exploration Station, dry and complex scientific textbook principles come to life in hands-on activities that kids of all ages can enjoy. Teachers have a choice of three 50-minute programs tailored to different age groups: "Living in Space," "The Sun's Planets" and "Space Propulsion." Even adults occasionally drop in, like Amy Jo Curry of Pennsylvania, who enthuses as she tries on a spacesuit: "I'm one of those big kids at heart."

It's no surprise, then, that the six-year-old Exploration Station is one of the most popular educational programs offered at KSC. In fact, its popularity has increased so much that with additional space and personnel, "we could probably double the

The popular Exploration Station program at Kennedy Space Center brings scientific principles to life with hands-on examples. (right) Adult station visitor Amy Jo Curry fitchecks a spacesuit.

Writing and KETS ch imaginations.

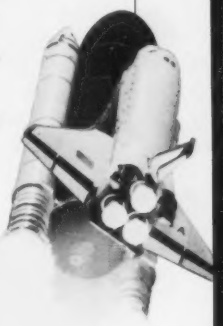
business," comments project coordinator John Ulrich.

At NASA centers nationwide, the agency is using programs like these to extend the excitement of space from its laboratories to the nation's classrooms, and to demonstrate that science and math education can be fun as well as practical.

"NASA is clearly not the department of education for the federal government," says NASA's Deputy Administrator, James R. Thompson. "But in a sense, NASA is all about education. We explore in our science programs. We invent and create in our technology programs and we stimulate, I believe, the very heart and soul of this country."

NASA is an educational agency for the simple reason that space is a stimulus and a magnet for learning. Whether it's growing space tomato seeds in the classroom or working on actual mission hardware as a college-level intern, the agency invites students of all ages, pre-school to graduate school, to participate in programs at its various field centers. The effect can be electric.

At the Stennis Space Center, for example, a program called Early Education Monday sparks the very youngest imaginations by presenting four- to six-year-olds with a universe they can see, hear and touch. The program, which began in March 1990, is held every Monday between September and May in the Stennis visitor center. When a class arrives, the pre-schoolers get a brief overview of NASA's past (an Apollo capsule is right there on display) as well as a preview of future space stations, Moon bases and Mars expeditions. Once the kids' interests have been piqued, the questions pour in. How do astronauts eat and drink in space? How do they go to the bathroom or brush their teeth on the Space Shuttle?



A mock adventure in space, complete with launch and landing, helps provide some of the answers. Stories, skits, slide shows and tours round out the four-and-a-half hour program, which alternates periods of quiet listening with periods of hands-on active participation.

Stennis's Early Education Monday isn't expected to give young children a full understanding of space science. But like the Spacemobile program (see next page), it complements a school's existing curricula in Earth, planetary and space sciences.

Spacesuit To Go!

For a teacher to reach a student, it often takes ingenuity, charisma, and hard work. But for NASA's education specialists, nicknamed "Spacemobilers," it also takes half a year on the road, logging as much as 40,000 miles annually.

The Spacemobilers, NASA's traveling teachers who move from school to school, day after day, coast to coast, "are a breed apart," says Jim Poindexter, who oversees a fleet of four Spacemobiles based at the Johnson Space Center.

Nationwide, NASA has 34 of the vehicles, which operate in small groups out of most NASA centers. The Spacemobiles are specialized vans packed with spacecraft models, literature, lessons, space artifacts and a multitude of teaching aids. The people who drive them are NASA's missionaries, and they've been fanning out across the United States to spark the imaginations of school children for almost 30 years.

"We don't have a script, and we're not actors. Education won't work like that. You have to feel out the audience, find out what gets them excited and what piques their interest."

"A Spacemobiler visits a new school every day. He stays in a different motel every night. Each day he enters a new world," Poindexter explains. "It's a tough job. Within 30 days, you'll either get hooked and stay with it or you'll leave the program."

All Spacemobilers are teachers. To qualify for the job, they need all the qualifications for a teaching position, plus years of experience in the classroom. But no class was ever like this. A typical day begins at the same motel where you arrived the night before. When you awake, it's still dark—the Spacemobile has to be at the school of the day by 6 or 7 a.m. Traveling agendas are planned through each state's Department of Education, and the day's schedule at a particular school is arranged over the phone.

The morning begins with setting up a stageful of gee-whiz demonstrations: satellite communications, solar power, gravity and orbital mechanics, spacesuits, principles of flight, whatever's most interesting and exciting. Anywhere from 1,000 to 1,500 pounds of equipment are unloaded from the Spacemobile and arranged on a stage provided by the school. On your arrival at the school, you're often greeted by your own photo and

With the help of a spacesuited potential astronaut, JSC spacemobiler Angelo Casaburri reveals the mysteries of the planets. The spacemobile program reaches out to students in schools all over the country. (right) Science experiments delight and lead to inquiry when NASA people share their knowledge and experience.

biography tacked to a bulletin board, says Angelo Casaburri, a veteran Spacemobiler for more than 11 years.

The students always get involved during the presentations, trying on spacesuits, competing for answers or spinning to demonstrate centrifugal forces. But every school is different, says Casaburri.

"We don't have a

script, and we're not actors. Education won't work like that. You have to feel out the audience, find out what gets them excited and what piques their interest," he says. "It's one thing to take a Shuttle model and say the payload bay is 15 feet by 60 feet. But it's another to take ropes, send four kids out to hold them in a 15-foot by 60-foot rectangle, then have the whole student body stand inside."

After the assembly, the Spacemobiler usually attends a few classroom sessions. Here the information gets more specific, depending on the teacher's request.

Casaburri carries slide presentations on the Solar System, living and working in space, lunar bases, Space Station Freedom, Mars bases and a host of other subjects.

Day's end might mean a drive to a new city, new motel and new school. Or maybe it's the same motel and the same city, but a different group tomorrow. Only one day is spent at each school because demand for the program is so great and the territories are so large. "If you spend three days in the same motel, it feels like home," Casaburri says.

What makes the Spacemobiler do it? Why spend at least 160 days of each year roaming around like a Gypsy with a textbook? If it's been a good day, Casaburri explains, "the kids are hanging on you when you leave. They don't want you to go." ●

—By James Hartsfield, JSC

"In a sense, NASA is all about education. We explore in our science programs. We invent and create in our technology programs and we stimulate, I believe, the very heart and soul of this country."

-NASA Deputy Administrator James R. Thompson

From Curiosity to Careers

Encouraging interest in math and science at an early age is important, and so is the follow-through that results in successful academic and work careers. That's why NASA's Summer High School Apprenticeship Research Program (SHARP) and other programs like it are providing opportunities for older students, particularly among underrepresented minorities.

What makes the SHARP program work is the person-to-person communication and concern shown by adult mentors. Cyn Gosier, a teacher in Prince George's County, Maryland, has led the SHARP program at the Goddard Space Flight Center for seven summers, reaching out to 10th, 11th and 12th graders with her warmth and dedication.

At Goddard, each SHARP student works with a NASA mentor for eight weeks in the laboratory. The students keep a lab notebook and journal and meet regularly with Gosier to discuss their Goddard experience. Apart from getting a chance to see first-hand what "rocket scientists" really do all day, students attend workshops on selecting a college, surviving on campus, getting scholarships and participating in NASA co-op programs. They also visit other technical facilities such as NASA's Lewis or Langley Research Centers, the Maryland Science Center and the Smithsonian Air and Space Museum. When the eight weeks are up, the students produce posters describing their summer's work in the laboratory, which are exhibited at the graduation banquet for parents, mentors and guests.

The results from SHARP are dramatic. Of 191 students who've been through the Goddard program, 100 have earned bachelor's degrees, 75 are still in college, 18 are still in high school and several are working on advanced degrees. What's more, 76 percent of SHARP graduates have continued on in technical fields.

Mentoring also is an essential part of the Space and Biology program at the Ames Research Center, which is aimed at students

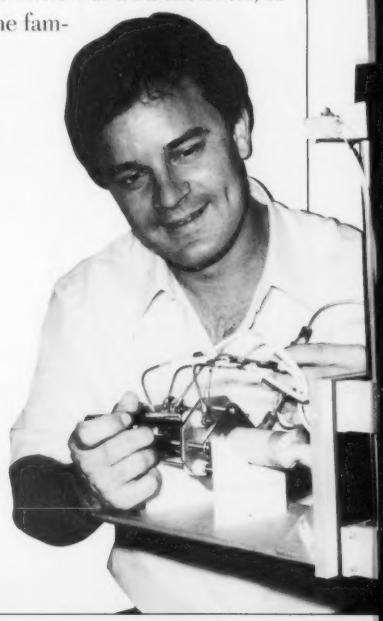
who've already shown an aptitude for science and math. The program was designed to quench what former Ames Life Science Director Harold Klein, who founded it in 1968, described as "a thirst for knowledge in space biology and the eagerness of high school students and teachers to participate in research-oriented programs."

In the past 23 years, the format has remained largely unchanged, according to Darrin Belgarde, the program's coordinator. Students spend at least six hours each week with an Ames scientist or researcher, and attend weekly lectures on various scientific topics. At the conclusion of the program, which runs during the school year, participants are eligible to compete for an all-expenses-paid eight-week summer fellowship at Ames with their researcher.

Since its inception, Belgarde said the program has nearly doubled in terms of the number of students enrolled (47 are participating this year). 33 high schools are involved in the program, with some students traveling as many as 50 miles to participate. Since each school is limited to nominating no more than two of its gifted students, the competition can be stiff.

Pre-school and kindergarten students size up a model space shuttle engine at Stennis' visitor center's Hall of Achievements during their Early Education Monday tour. (below) Graduate and undergraduate students take their first professional steps with Lewis Research Center's intern program. Hands-on laboratory experience and professional guidance add up to careers in space and aeronautics.

Several alumni of the program have even returned to Ames. One, Karen Gundy-Burlette, now works in the center's Applied Computational Fluids Branch, and recently was a mentor herself. Ironically, though, space biology turned out not to be her field. After interviewing with Ames researchers, Gundy-Burlette says, "I realized that I've always liked aeronautics and aerodynamics. In fact, my great uncle was a barnstormer, so it must run in the family." She's now studying for a doctorate in aero-



Moon Juice and Saturn Soup

During the third week of February each year, Tennessee children from the Great Smoky Mountains to the Mississippi River take a much anticipated trip. Aboard the Space Shuttle Orbiter Imagination, they soar through the Solar System, cruise constellations, step back in time to explore the Moon with the Apollo astronauts, and jump into the future to make discoveries onboard Space Station Freedom. It's all part of a long-term "mission" called Tennessee Space Week, launched jointly by NASA and the Tennessee Education Association (TEA) in 1987.

Billed as "An Adventure in Education," Tennessee Space Week is one of the largest NASA cooperative education projects (U.S. Space Camp will join the partnership in 1992). The focus isn't just on math and science, though—for one whole week, space is used as an inspirational theme in all parts of the curriculum, from algebra to art.

Teachers in grades K-12 can choose from a list of lesson plans and activities in virtually any subject, from planetary science, aerodynamics and astronomy to language arts, social studies, even foreign languages. Phys-ed classes turn into astronaut training facilities as students compare their pulse rates before and after exercise to those of John Glenn or Yuri Gagarin at liftoff. Home economics students study nutritional requirements for spaceflight, while art students learn astronomy as they create mobiles of the constellations. Teachers also pick up valuable instructional materials, ideas and background information from a special edition of *Tennessee Teacher* magazine timed for Space Week.

"One of the best things about Tennessee Space Week is that there's something for every subject area, so all our teachers can participate," explains TEA President, Relzie Payton.

Contests are part of the fun for teachers as well as for students. Tennessee Space Week is the one time of the year when kids are encouraged to turn pieces of paper into identified flying objects. For the Space Shuttle Throw contest, the students are limited to one 8 1/2" x 11" sheet of standard weight construction paper, cellophane tape, and a payload of one U.S. penny. Whoever builds the most aerodynamic Shuttle wins (flights are judged by accuracy and distance). Local winners are then eligible for a statewide drawing, and scholarships to attend U.S.Space Camp are awarded for each grade level from 4 to 12.

Tennessee Space Week is the one time of the year when kids are encouraged to turn pieces of paper into identified flying objects.

Bill Ingalls

TEA President Relzie Payton introduces NASA Administrator Richard H. Truly as Tennessee Space Week Honorary Chairman to an exuberant Space Week audience. Truly noted that the TEA's efforts developed a model that has stimulated similar programs around the country.

For teachers, there's the "I Want to Be a Space Cadet" contest, with a grand prize of a scholarship to attend a special Space Camp for educators. In addition, 40 teachers, all from different public school systems in the state, participated last year in a week-long Teachers' Camp at the Johnson Space Center, where they gained knowledge about NASA and aerospace education that they now share with their colleagues back home.

Even school principals can participate. Each morning, along with the usual announcements over the PA, the principal reads a question of the day chosen from a set of 150 space trivia questions and answers. Students have all day to drop their answers into a box in the cafeteria. The homeroom with the most correct answers at the end of the week wins a prize—often a class party sponsored by the school PTA.

In many schools, enthusiasm for Tennessee Space Week infects everyone on the staff. Cafeteria workers don alien masks and dish up Pluto Pizza, Venusian Veggies, Moon Juice (milk), Orbit Burgers, or Saturn Soup. Bus drivers sport badges designating them as honorary Shuttle Pilots.

The media get involved, too. Tennessee Space Week has established a network of television "Space Stations" as local sponsors. These stations, all network affiliates, dedicate a portion of their evening newscast to aerospace news every night during the week. The stations also run the Space Trivia Contest over the air, and give away official Tennessee Space Week t-shirts and baseball caps to correct callers. Sponsoring stations have found that Space Week, which runs during a Nielsen rating period, even boosts viewership.

Bob Brown, director of NASA's Educational Affairs Division, says that Tennessee Space Week "institutionalizes" aerospace education rather than just being a one-time event. Brown also praises the active involvement of the Tennessee Education Association, which represents some 45,000 teachers. "That's a powerful statement about the importance teachers give to using aeronautics and space as a vehicle for enhancing education—regardless of the subject," says Brown.

Work is underway on next year's Tennessee Space Week, slated for February 24 through 28. Each year the project seems to grow in scope and enthusiasm, and no one has yet run out of ideas for new activities. Like the exploration of space, the possibilities seem limitless. ●

—By Dawn Charles, Launch Director, Tennessee Space Week

(used with permission of TEA)

Sheepskins for Space

Doctoral research on the Moon? A Master's seminar on Mars? It's not reality yet, but to many high school and undergraduate students it's more than science fiction, thanks to NASA's Space Grant College program.

Authorized by Congress and initiated in 1989, the Space Grant College network is helping universities around the country establish capabilities in aeronautics, space and related fields. More than 200 schools in 47 states are currently involved in the program, with more applying every year.

"Teleprospector"—a rock-hunting robot being designed for lunar geological studies—is just one of the many new projects underway in Hawaii using funds provided by the Space Grant College system. The program has given faculty at the University of Hawaii's Manoa and Hilo campuses the financial means to introduce students to the finer points of planetary geology, robotics, and life sciences—all of which will need to be addressed before humans return to the Moon. Hawaii already has taken major steps in training the next generation of space scientists through undergraduate fellowships, new courses and sponsorship of exhibits at local museums.

The lunar robot "Teleprospector" is one of many interdisciplinary projects that University of Hawaii students are now working on as part of the new Hawaii Space Grant program.

A special two-week course called "Exploring Planets in the Classroom" was given for school teachers and school librarians during this year's summer session, as well as an astronomy program for Gifted Native Hawaiian Children, who compare observations from atop Mauna Kea with those of early Polynesian navigators.

The Space Grant College program in Hawaii has built on the state's existing research base as well as its growing interest in the commercialization of space. Hawaiian students have been awarded fellowships to study Magellan radar images of Venus and to develop methods of using Landsat and airborne infrared data to investigate vegetation patterns and volcanic activity. Other students have used Space Grant money to travel to the 14,000 foot-high summit of Mauna Kea to collect data on comets and distant galaxies using CCD cameras and photometers attached to research telescopes.

Hawaii's participation in the ACTS (Advanced Communications Technology Satellite) program will augment the state's research efforts in relation to NASA's Earth Observing System (EOS) and the European ERS-1 radar satellite. Similarly, the daily collection of AVHRR (Advanced Very High Resolution Radiometer) images to study ocean phenomena around Hawaii has promoted sufficient interest at a local science museum that the Space Grant College is considering both a book and an exhibition for the general public on "Satellite Views of Hawaii." The exhibit would be part of the state's celebration of International Space Year (ISY) in 1992.

Where will the Space Grant College program take the University of Hawaii next? As educators, we encourage students to work toward careers in math and space science. But as researchers, the Space Grants open exciting new horizons for faculty, undergraduate and high school students alike, and provide the opportunity to plan research that will someday take us back to the Moon.

—By Peter J. Mouginis-Mark,
Director, Hawaii Space Grant College

nautics and astronautics at Stanford University.

Over the years, the Ames program has won the respect of San Francisco Bay Area educators. Says Horace Lucich, a teacher at Willow Glen High School in San Jose, "This is the best course you can take in your 12 years of schooling."

Meanwhile, at the Lewis Research Center, NASA is working with a consortium of universities, federal laboratories and private sector companies to help qualified undergraduate and graduate-level interns get hands-on experience and take their first steps on the career ladder. Interns at Lewis are given assignments in R & D projects under the personal guidance of NASA professional staff members in fields ranging from aeronautical propulsion to space power and microgravity science.

Interns who've been through the program, which is co-sponsored by the Ohio Aerospace Institute, say the NASA experience—particularly the personal guidance from Lewis mentors—challenged them to learn more. One intern said, "My mentor made himself available to answer my questions and offered much insight when I needed assistance."

Teaching the Teachers

While these NASA education programs all focus on students, the most important "student" in the classroom often is the teacher. And if that teacher is an English Lit

major who can't tell a bunsen burner from a nuclear reactor, science can be a daunting subject. That's where the Jet Propulsion Laboratory's "Comfortable Approach to Teaching Science" (CATS) program comes in.

Studies show that science averages the least amount of classroom instructional time of any subject. Teachers cite their own weak science backgrounds, as well as a lack of adequate instructional materials and facilities, as the reasons. CATS can help.

The four-week intensive program covers topics that are unfamiliar to most elementary school teachers: electricity, light, sound and astronomy. Rather than trying to cover many subjects superficially, the teachers are given an in-depth background only in these four subjects, as well as ideas for presenting the material to their students. Mathematical concepts are used frequently to drive home the point that science and math are inextricably tied together.

CATS stresses teamwork. A single CATS team consists of one lower and one upper elementary school teacher from the same school, as well as the school principal. CATS, a joint effort with the California State Polytechnic University at Pomona, also includes a strong follow-up program, with monthly "cluster team" meetings and Saturday updates at JPL. For those unable to travel to Pasadena, a team travels to selected regions to present the follow-up sessions.

This philosophy of "teach the teacher" also guides Langley Research Center's NASA Education Workshop for Elementary School Teachers (NEWEST) program.

Each summer 23 teachers attend presentations by expert researchers, visit research laboratories and participate in hands-on sessions that translate NASA work to the elementary level, with a bit of fun and games added in for flavor.

A trip on the Space Shuttle? In NEWEST's "Spaced-Out Physics," teachers help a Langley aerospace engineer demonstrate the basic physics of a Shuttle mission. Toy water rockets, balloons, ice blocks, yard sticks and a plastic Shuttle take the place of supercold liquid hydrogen, sophisticated computers and the 100-ton orbiter, but the same scientific principles apply.

Cherry Wise, a first year SHARP student from Howard County, Maryland waits to discuss her summer work with guests at the graduation night banquet.

At the end of their two weeks of learning, the teachers get to show off their knowledge in a competitive "Aerospace Olympiad" with five events: Model Gliders, Aerospace Career Profile, Payload Packaging, Rocketry and Flying With the Hood, an exercise in navigation.

In an optional activity, the teachers experience powered or soaring flight. Thanks to the Langley Aero Club the abstract concepts of flight become real-world as the educators fly in a four-passenger Cessna. Soaring flight provides the realism of fundamental aerodynamics to teachers flown by the Virginia Soaring glider club.

It's all in fun, but it also shows the importance of applying book knowledge to actual experiences. With NEWEST, teachers' experiences can easily be transferred to the elementary school classroom, or even to their colleagues, thereby strengthening the school's science base.

The approach to stimulating interest in science and mathematics education varies at each NASA installation, depending on the

Dennis Olive

facility's unique strengths and resources. In 1989, Marshall Space Flight Center began development of a pilot program called LASER (Learning about Science, Engineering and Research) that connects teachers not only with current center staff and contractors, but Marshall retirees as well. More than 300 volunteers—all past or present Marshall employees—are helping Marshall's education staff develop special curriculum materials and a space technology course. They also give teachers science training, and provide selected students with learning experiences not available in their own schools.

On any Monday night you might find many of these professional scientists and engineers at the Huntsville Public Library serving as "study buddies," helping students in all grades with their math and science homework. The Marshall volunteers also make presentations in public schools and serve as tutors, field trip hosts, science fair judges and consultants to teachers.

(top) HIGH TENSION EXCITEMENT — High school students conduct electrical experiments in Marshall's project LASER Discovery Lab. (below) Ames Research Center mentor Muriel Ross and student Leslie Hansen confer on a neuro-vestibular research project.

In cooperation with a team of Marshall educators, the volunteers also give science and math presentations at the library's main downtown branch, where many children "hang out" until their parents return from work. These hands-on activities include the After-School Discovery Club and frequent "How To Do A Science Fair Project" workshops.

One of the LASER volunteers, Marshall electrical engineer Terry Minor, explains the motivation behind this community work. "I owe a lot of credit for my success to my teachers, friends, and my mother, all of whom instilled in me my interest in engineering and my strong work habits—contributions Project LASER lets me now pass on to others."

Perhaps the most far-reaching work of

these volunteers is in the space center's new Project LASER Discovery Lab, a 2,500 square-foot laboratory where a space technology course and curriculum materials are being developed to help teachers in other parts of the country. Groups of students and teachers test the materials at the Discovery Lab and in the classroom.

"It's not our intention to go to schools in other states and recreate these courses for them," says Pat Armstrong, the Huntsville school teacher employed by Marshall to direct the program development. "What we're doing is laying out a blueprint so that no matter who you are, where you are, or what size you are, you can use it."

The related space science and math materials developed in the Discovery Lab are distributed to teachers nationwide through Teacher Resource Centers located at all NASA field centers. And for teachers who aren't near a center, Project LASER has taken its act on the road. The first Mobile Teacher Resource Center—an eighteen-wheel tractor-trailer rig filled with printed materials, films and videotapes, and special computer software—rolled out of the parking lot in 1990, and now travels to school systems across the country. With funding from a growing number of corporate sponsors, the LASER truck is the first of what NASA hopes will become a small fleet of mobile resource centers.

The agency's efforts supporting education are even more wide-ranging than this sampler of programs, however. Through its role as the leader of the nation's civilian space effort, the agency represents the future to many young Americans.

Referring to future missions to the Moon and Mars, Administrator Richard Truly says, "All of this is going to happen because American society needs the sense of purpose, American students need the inspiration, American business needs the new technology, and the world needs the new knowledge. It is also going to happen because it is inevitable, and Americans are determined to be a part of it. We are a frontier people; this is the new frontier."

On any Monday night you might find many of these professional scientists and engineers at the Huntsville Public Library, serving as "study buddies," helping students in all grades with their math and science homework.

There's a more personal side to the story as well. NASA's people are what make the agency's educational efforts work. Each contact with a spacemobile lecturer, mentor, advisor or study buddy helps a student make new discoveries and new insights.

Who can predict the futures that will result? ●

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Contributors to this article include:
Susan Walsh, KSC; Merna Bridgeman, SSC; Elva Bailey, GSFC; Michael Mewhinney, ARC; Joanne Charleston, LeRC; Gene Vosicky, JPL; Shelley Canright, LaRC; Mike Simmons, MSFC.

If you would like to become involved in a NASA educational program as a mentor or volunteer, or learn more about the many programs offered by NASA Education Offices, contact the education office at your center:

Ames Research Center,
Garth Hull, (415) 604-5543;
Goddard Space Flight Center,
Elva Bailey, (301) 286-7207;
Johnson Space Center,
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Kennedy Space Center,
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Gene Vosicky, (818) 354-8592.

It was at least the hundredth time I had said those words from my post at a console of our "Space Classroom" in Huntsville, Alabama. But this time it was no simulation. This time, the STS-35 "Astro-1" crew onboard Columbia really answered—from 230 miles up in orbit!

The two hours that followed were filled with electricity, tension and laughter, as 42 middle school students at the Marshall and Goddard Space Flight Centers talked directly with the Columbia astronauts who taught the world's first lesson from space.

"Space Classroom, Assignment: The Stars" was the culmination of months of preparation and planning by NASA managers, teachers, and two groups of very eager students in Alabama and Maryland. Along with the lesson taught by the astronauts, "Space Classroom" included a live question-and-answer session, a ground-based lesson, a Teacher's Guide with lesson plans, and follow-up slide sets and video products.

My own involvement with the project had begun almost a year earlier, when I was asked along with Pat Armstrong, a Huntsville City School teacher who, like me, was on loan to Marshall, to help "a little" with a project we both thought would make a bold educational statement. By the time we finished, "a little" turned out to be a lot. We experienced the frustration of seeing the STS-35 mission rescheduled multiple times, the joy of working with terrific students, even the thrill of a classroom visit from President Bush as we were preparing our lesson months before the launch.

My job was to write, rehearse, and teach the ground-based lesson, and to help coordinate the three-day Astro-1 student workshop at Marshall. During the flight the students and I were to be in a classroom in an unoccupied part of the Science Working Area at Marshall, which would house science teams and their equipment during the flight.

President George Bush joins the Space Classroom and performs a flame test under the watchful eye of teacher Karen Widenhofer.

From the start, the STS-35 crew was enthusiastic. Sam Durrance and Jeff Hoffman were to teach the lesson, while fellow crew members Bob Parker and Ron Parise would field live questions from the students at Goddard and Marshall. "Space Classroom" was planned to take place just before and after a shift change on Columbia in order to involve all four astronauts and avoid interruption of mission science. During the 30-minute shift change, our ground-based lesson would reinforce the crew's lesson with hands-on activities.

To get the most from those 30 minutes, I drew up an outline of activities using diffraction gratings, a prism, slinkies, flame tests, and anything else I thought would help the middle-schoolers relate the electromagnetic spectrum to the astronomy conducted with the Astro-1 telescopes.

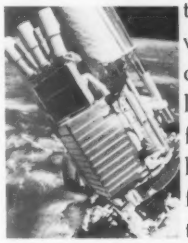
Once the plan was set, we started practice sessions, including one with stand-in "students" from the Head-

"HELLO, AS

quarters and Marshall Public Affairs offices. My handmade posters and the plain tables made me worry that this small town teacher would embarrass NASA. But as the astronauts began their practice lesson, beamed to us from the Johnson Space Center, I relaxed. It was the first time through their lesson, too; they were reading from their notes and holding up pictures just like I was.

Many more simulations followed in the following months. In the meantime, 12 real students were chosen from middle schools in Georgia, Alabama, Tennessee, and Mississippi, and Goddard chose 30 more from schools in Howard and Prince George's County, Maryland.

With each launch slip, the time allotted for my ground-based lesson kept changing. In practice sessions, the cameramen had to try to keep track of what shots I had cut out, and they had a hard time following me. I had a hard time following me. By the end of November we were all sick of the electromagnetic spectrum, but after one more rehearsal we were ready for anything.



Astro-1 telescopes scan the stars from the cargo bay of the Space Shuttle Columbia. (above, right) Marshall Space Classroom student, Chris Battle, works the computer station in a Space Station Habitation Module mockup.

The week before launch passed quickly. A pre-launch video conference "starring" mission scientist, Ted Gull, and NASA Educational Affairs Director, Bob Brown, was beamed out to some 30,000 educators, renewing our excitement.

Finally, in the early morning hours of December 2, 1990, Columbia and its crew of six lifted off from Cape Canaveral.

During the next several days I watched NASA Select TV with fascination. I knew the people whose voices I heard, knew some of the anxieties and hopes they carried with them as they circled the Earth. A reporter had asked me months earlier whether I would ride in the Shuttle given the chance. My fear of heights had made me say no. But now, watching Columbia orbit the Earth with real people on board, I knew I would do it in a heartbeat.

Our Space Classroom participants arrived at Marshall onWednesday evening. Despite advice for me to get some rest before the Big Day, their energy was so high I just wanted to be around them. Former teacher Pam Bacon from NASA Headquarters felt the same way, and was like a cheerleader the whole way through, encouraging us and even wearing socks with the Jetsons' dog Astro on them on the day of the lesson.

The morning of Friday, December 7, I showed up at our classroom in the Science Working Area promptly at 6:30. After the

by Karen Widenhofer

STRO!... ”

Lesson activities and worksheets in the Teacher's Guide for "Space Classroom, Assignment: The Stars" were used by thousands of teachers during the STS-35 mission. Space Classroom also was seen by students and teachers live on NASA Select and several cable and public television channels. A NASA educational video, using clips of the Space Classroom shuttle lesson, the ground-based lesson, student participation at Goddard and Marshall, and workshop activities will be available through the education offices at NASA field centers, as are the accompanying Teacher's Guide and slide set.

students arrived we briefed them on how to handle their microphones and gave them other pointers, like how to avoid the loud SMACK of a slinky when demonstrating the relationship of wavelength to energy. I reminded them how much I needed them to smile at me and encourage me to relax if I got tense.

I made the first voice check at 7:35. At 8:15 we did our "walk-through"—the 12 students and I walked through the Science Working Area toward a camera, á la

"Backstage with David Letterman." No one tripped, and as we entered the Space Classroom, five students accompanied me to the communications console to follow the voice protocol leading up to our calling the crew

for the lesson.

It went smoothly, with no delays or confusion. Then I said, "Astro, this is Space Classroom in Huntsville, Alabama. We have a group of students here at MSFC and a group at Goddard..."

It wasn't dry or stale after all! Through the wonders of technology, we could hear each other in "real time" across space.

Now Sam Durrance in a red shirt and Jeff Hoffman in a sporty astronaut tie began their lesson, explaining Astro's mission and how it related to the electromagnetic spectrum. The kids watched, mesmerized. Meanwhile, I was sitting to the side of the set, scanning my outline one last time.

Then came a surprise announcement. There was a chance that the ground-based lesson would go 45 minutes instead of 30! But they wouldn't know until one minute before I started!

After praying for wisdom and composure, I remembered that we had done this a million times before, and that no matter how poorly I did, it would still be better than what anyone they called on NOW could do. The word came—I had 45 minutes. Standing at my designated spot, I said thank you, dove into the lesson...and the last of my fears evaporated as I started to teach. The students listened and interacted beautifully, and seemed oblivious of the cameras.

I was starting to feel pretty good. No disasters, even when we had the kids perform flame tests with a propane torch. Then my floor manager, Sheryl, who until now had been holding up "Doing

great!" and "Slow down!" cards, held up a sign that said "Problems with the Shuttle — STRETCH!" I read the sign, trying not to change my facial or vocal expression each time she held it up. Somehow I muddled through, throwing in everything I could about TDRSS, and the Astro poster and booklet, stretching the 45 minutes to 55. Someone said later they wondered if my credit cards would be next!

As soon as the communications problem was resolved, the call came from Columbia that Ron Parise and

Bob Parker were ready for questions. The astronauts were tired at the end of their shift, but their enthusiasm to be part of this historic activity showed. Our 12 students had five minutes for questions, then the Goddard group had ten, followed by another five from Marshall. The students

wanted to know what had been the most challenging aspect of the mission so far, whether the telescopes really used diffraction gratings, and how the ASTRO data would be used. Like all of us kids in the room, they were fascinated by weightlessness.

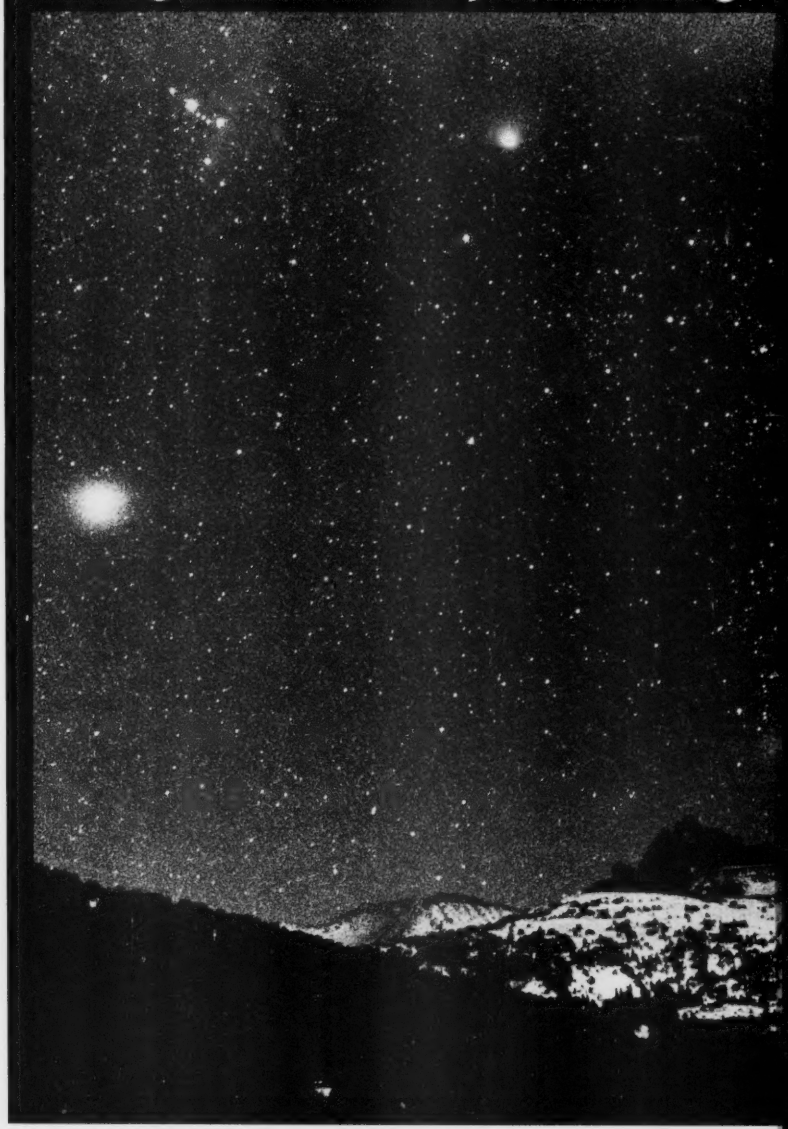
When it was all over, everyone was smiling and patting each other on the back. I couldn't believe how smoothly the voice calls, lesson, and questions had gone.

Afterward, the press came up to talk to us. I gushed my enthusiasm about the program, about the lesson, about everything. Mostly, though, I was excited about not having to stretch out another ten minutes. ●

Karen Widenhofer is a Madison County, Alabama high school science teacher presently on loan to the Marshall Space Flight Center to assist with the development of Marshall's Project LASER (Learning About Science, Engineering and Research).

Drums In

After more than three decades Intelligence is finally about to get



One year from now The Search begins. On October 12, 1992, the 500th anniversary of Christopher Columbus' historic landing, a new group of explorers will venture forth in a vastly larger sea. These New World children, some 25 generations removed from Isabella's reign, will begin listening to distant stars for signs that humans are not alone in the universe.

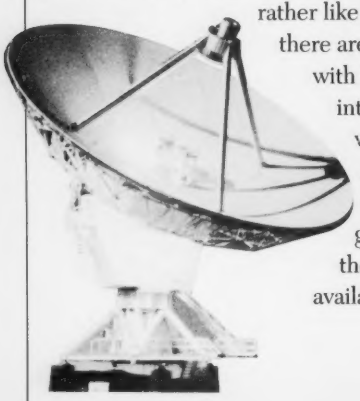
From the giant dish at Arecibo, an hour west of San Juan, Puerto Rico, the first "listen" of the targeted search will take place. At the same time, five hours north of Los Angeles, in the quiet, isolated desert surrounding NASA's Goldstone Deep Space Network tracking station, an exhaustive all-sky survey will get underway.

When the Search for Extraterrestrial Intelligence (SETI) begins at last, those present at Arecibo and Goldstone will be able to ponder back to when it all began....

It was 1959. Sputnik 1 had already reentered the atmosphere. The United States had orbited Explorer 1 the year before, and a Soviet probe had finally reached the Moon on the seventh try. The Space Age had begun, but color television was still a couple of years away.

"...There are civilizations..."

That fall, Philip Morrison and Giuseppe Cocconi, two Cornell University scientists, published a two-page article in the British journal "Nature." Their conclusion was profound They wrote that "near some star rather like the Sun, there are civilizations with scientific interests and with technical possibilities much greater than those now available to us....



The Sky

the Search for Extraterrestrial serious.

by Charles Redmond, Hq.

Allan E. Morton

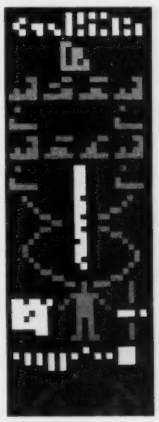
The presence of interstellar signals is entirely consistent with all we now know, and... if signals are present the means of detecting them are now at hand."

Morrison and Cocconi continued, "Few will deny the profound importance, practical and philosophical, which the detection of interstellar communications would have. We therefore feel that a discriminating search for signals deserves a considerable effort. The probability of success is difficult to estimate; but if we never search, the chance of success is zero."

The article was noted by a few. About that time a young radio astronomer arrived in the backwoods of West Virginia. Frank Drake was then helping to build the National Radio Astronomy Observatory at Green Bank. While working on his Ph.D., Drake had noted a certain frequency that might be interesting if one were to look for intelligence elsewhere. So, while working to build what was then a very large 140-foot radio telescope, Drake and his colleagues completed the observatory's first dish, an 85-foot antenna, and began in 1960 to listen to two nearby stars at the frequency Drake had identified.

Although the attempt to detect signals from these nearby stars didn't find anything out of the ordinary, Project OZMA, as it was called, did bring together a core group of people who would create a new field of scientific endeavor.

In 1961 the National Academy of Sciences held a meeting at Green Bank that included Cocconi, Morrison, Drake and several other pioneers of SETI. Among them were Melvin Calvin, an evolutionary biochemist who learned he had won the Nobel Prize for his work on photosynthesis while



A visualization of one of the earliest radio messages beamed by Frank Drake into the cosmos. (above)

attending the Green Bank meeting. In 1958 Calvin had written that "we can assert with some degree of scientific confidence that cellular life as we know it on the surface of the Earth does exist in some millions of other sites in the universe."

"...Do it carefully and do it slowly..."

Another attendee, Hewlett-Packard electrical engineering wizard, Bernard Oliver, had visited Drake in 1960 at Green Bank and became interested in SETI. In 1962 Oliver would publish a paper on a "Radio Search for Distant Races." A year later, A.G.W. Cameron, a noted Solar System theorist and, later, NASA lunar sample investigator, would edit a volume entitled, "Interstellar Communication," followed in 1966 by Iosef Shklovskii's and Carl Sagan's, "Intelligent Life in the Universe". SETI was slowly developing its own body of literature.

In 1968 John Billingham had already been at NASA for five years—three at the Johnson Space Center working on technology for keeping humans alive in space capsules, and two at the Ames Research Center, helping to head up a new biotechnology group. It was Sagan and Shklovskii's book that "really got me started," recalls Billingham. "It made me ask three questions: Is there really a sound scientific rationale for postulating a search for extraterrestrial intelligence? If the people of planet Earth ever seriously wanted to begin a thoroughgoing search for extraterrestrial intelligence, what technical engineering approach would be taken? And who should do it?"

"It's no good trying to explain SETI in 30 minutes to a classical astronomer, biologist or engineer. It simply doesn't work. I can remember giving talks to colleagues on panels and overhearing one senior NASA astronomer say, `What is he talking about?'"

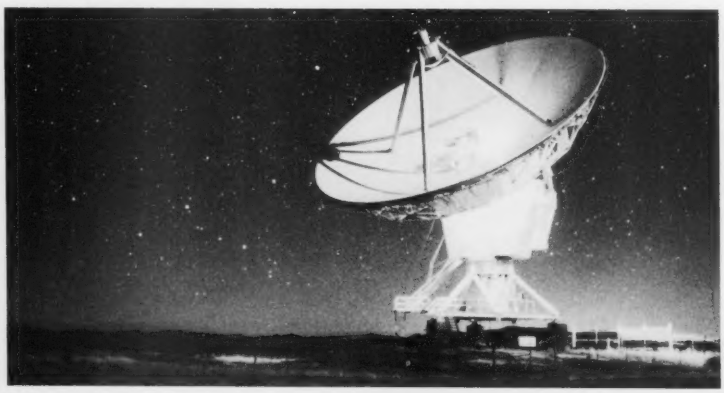
— John Billingham

Billingham thought that since NASA's mandate was to explore, surely it should play a role in such an enterprise. And Ames, as one of the agency's advanced think tanks, should lead the way.

The following year, 1969, Hans Mark became the new center director at Ames, and Billingham raised the issue of SETI with him. "He paused for 10 seconds and then said do it, but do it carefully and do it slowly," Billingham recalls. By the next summer a group at Ames had begun studying the feasibility of carrying out a search for intelligence elsewhere in the universe.

In 1971 Billingham invited Oliver to help direct a major study, with the participation of 25 academics from around the country, on how one might go about looking for extraterrestrial intelligent life. The group's report, "Project Cyclops: A Design Study of a System for Detecting Extraterrestrial Intelligent Life," was a milestone. It was the first time a government-sanctioned group was suggesting that life in the universe is not necessarily limited to planet Earth. Furthermore, it said we now have the engineering capability to conduct a comprehensive search, and described a system that could do the job. "Cyclops was well received as a technical masterpiece, mostly due to Barney Oliver's expertise," Billingham says.

Among the basic tenets of the report were that planetary systems are the rule, not the exception, and that establishing interstellar contact might greatly prolong the life expectancy of both the



Allan E. Morton

Antennas similar to this one in Socorro, New Mexico, will participate in the SETI program.

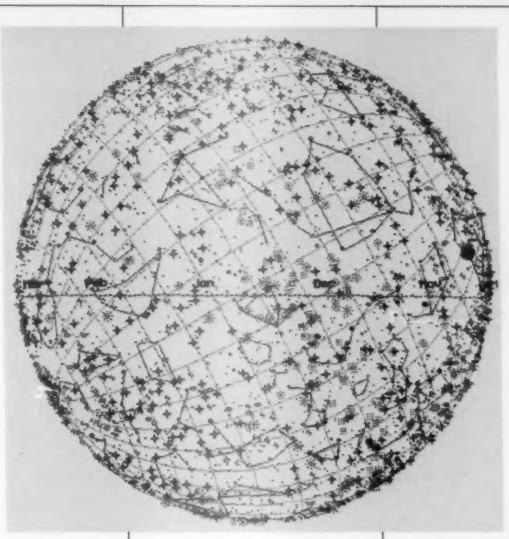
discovering and discovered civilizations. The Cyclops group held that listening for signs of life is vastly cheaper than looking with spaceships, and that such a search is a valid scientific undertaking. Perhaps the most profound conclusion of the report was that NASA should begin such an undertaking and that the discovery of any signs of life elsewhere must be publicly reported.

With Cyclops complete, Billingham created an interstellar communications study group at Ames to put together an actual program plan—"how you would really study this in the characteristic, exhaustive NASA fashion." The first funding came from NASA Headquarters in 1975 and 1976. Billingham says the Ames group and their outside panelists did "a pretty exhaustive study of the scientific and engineering basis for SETI." The extended group held workshops and produced another report, edited by Billingham and Morrison, who chaired the science workshop.

By the time their report, The Search for Extraterrestrial Intelligence, came out in 1977, NASA had test flown the Shuttle and set two robots down on the surface of Mars.

"Viking was very stimulating," says Billingham, "for the obvious reason that if it discovered life on Mars, we would know that life was widespread throughout the universe.... However, everybody realized that the chances of Viking discovering microbial life on Mars were not high, and that we would do SETI anyway. It would be the only other promising way to search for extraterrestrial life in the future." That same summer, George Lucas's epic adventure, Star Wars, played to packed theater crowds.

In February of 1978, Philip Morrison was interviewed by Jane Pauley on NBC's "Today" show. She asked Morrison what he expected to find. "I expect a long search of decades," he answered. "It's a needle in the most gigantic haystack in the universe." When Pauley asked Morrison if he expected to see results in his lifetime, he admitted, "I don't know. I'm hopeful. It's like any search, you keep on trying. And when you've tried, you might find it tomorrow, you might not find it for 20 years. I can't say, but you must look. You must seriously look."



This dot-studded orb depicts the sky as humans might view it on the evening of October 12, 1992, when the SETI program begins. The faint lines depict the outline of familiar constellations. The solid line bisecting the center of the image is the plane of the ecliptic. The dots comprise the known galaxies which can be seen from Puerto Rico on that evening—the "s"-shaped dots represent spiral galaxies, the square objects represent open clusters of galaxies, the "o"-shapes are oval galaxies. The objects which look like a circle with crosshairs are the stars which are part of the SETI targeted search—likely places where other forms of life might have evolved - or might yet evolve.

Can you lead a civilization to water?

The NASA SETI program survived a round of congressional sniping during the late 1970s, and entered the `80s as a collaboration between Ames and the Jet Propulsion Laboratory. All the time, according to Frank Drake, Billingham was "the man behind the scenes. He's the one who put the ingredients together to make things cook."

That cooking resulted in SETI's inclusion in NASA Office of Space Science and Applications program plans, as well as its recommendation by the Life Sciences Advisory Committee and other outside groups. Meanwhile, Ames and JPL continued to work together (with Ames as the lead center) and add dedicated SETI staff, including radio astronomer Michael Klein to head the JPL effort.

The SETI search that begins in 1992 will follow a dual search strategy, as recommended by the NASA studies of the 1970s: Look at the whole sky over the long haul, but also look at a select set of target stars within 80 light-years.

To accomplish either of these goals required two technical gizmos. One was easy: a large radio telescope. Not only did NASA have the cooperation of a number of university and national radio telescope

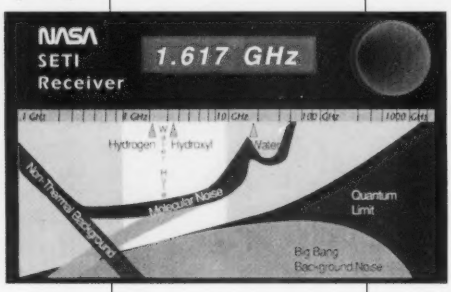
observatories, including the remarkable and unique 1,000-foot dish at Arecibo, but it also owned the Deep Space Network's radio telescope in the Mojave desert, a dedicated 100-foot dish, and comparable antennas at DSN stations in Spain and Australia.

The second gizmo was more problematic, and would take a decade to effect. In 1971, the Cyclops study looked at the electronic requirements for actually listening to distant stars. The strategy called for SETI to listen in the microwave region of the spectrum, at frequencies between one and ten billion cycles a second. This slice of the spectrum is naturally quiet. Background noise from the Big Bang and noise from galaxies, stars and interstellar matter are all at a minimum between one and two billion cycles a second (1 and 2 Gigahertz). Also in this region are the spectral signatures of hydrogen (1.42 GHz) and the hydroxyl radical (1.612 and 1.72 GHz). Because the addition of hydrogen to the hydroxyl radical produces water, the narrow band between these frequencies has been dubbed the "water hole."

The strategy devised by the SETI group called for listening to these selected frequencies for intelligible signals. Because other civilizations could also be expected to recognize the "quiet" nature of this band, the SETI team figured this was the natural window for sending interstellar radio signals.

But detecting an extremely faint signal over such long distances demands a tuning dexterity beyond most receivers. The transmission could be on a single frequency, or it could be on a series of frequencies, like modern television signals. It could be broken into very low density information, like old railroad telegraph systems—dot, dot, dash, dash—or it could be very complex and compressed, like FM stereo or color television. Listening to even a single star, at all the right frequencies, with all the right combinations of detection protocols, would have been a very tricky problem in the late 1970s.

"SETI is a force of reason in this world. Deep down, it forces you to think of the human race from a cosmic perspective."



Clearly some new technology was required. In the 70s the SETI group had described a (future) system that could scan thirty billion data points every second. This is where the Ames-JPL cooperation paid off. Ames worked with Stanford University to develop a prototype "multichannel spectrum analyzer," which could be reduced to a single integrated circuit.

The predictions of the SETI group in 1977 were right on target. Nearly ten years later, such a prototype was actually built and tested. This chip, together with the radio antenna dish and the programs that run them, constitute the heart, soul and mind of SETI search technology.

When the search actually begins in Arecibo and in the desert at Goldstone next year, 30 years of dreams will come to the moment of realization. Within the first hour on Columbus Day, 1992, the SETI team will cover more astronomical territory than all 60 searches conducted in the past 30 years combined.

"...What IS he talking about?"

Billingham began his efforts 20 years ago, at a time when he says SETI "was startlingly new to people who were dealing with more commonplace approaches to space. When we explained to people from all branches the scientific logic, which is complicated and which only a few of them knew before, they would remark, 'Gee, that makes sense.' But you have to take time. It's no good trying to explain SETI in 30 minutes to a classical astronomer, biologist or engineer. It simply doesn't work. I can remember giving talks to colleagues on panels and overhearing one senior NASA astronomer say, 'What is he talking about?'"

But, Billingham says, "there is nothing in the world to equal the power of a good idea. And that kept us going." Today, he says, SETI is "pretty well endorsed" by

the scientific community.

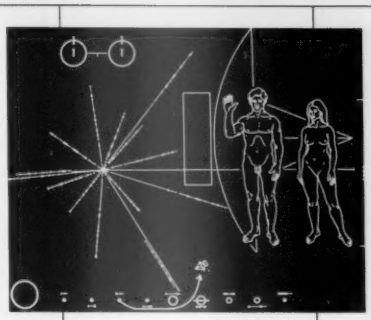
When Columbus set forth, on the strength of Isabella's money and his own convictions, his discoveries changed the future course of events for the population of an entire planet. When the SETI pioneers set forth in October 1992 to listen for evidence of other civilizations, what will happen?

Again, the SETI people (and the International Academy of Astronautics) have some ideas. The first question, they say, is what do you do if you get a signal. Billingham says the "Declaration of Principles", a SETI document developed by the International Academy of Astronautics this year, addresses this question directly. The document calls for widespread dissemination of all information about a signal in a completely open fashion.

But the declaration only deals with the first few weeks or months. Billingham says, "We should also ask about a reply from Earth!" Studies for a second Declaration will ask the following very simple questions: Assuming we have a signal, should we humans reply? Who decides? If we decide to reply, what should we say? How do we say it?

Billingham believes that "this is very much a responsibility of the people of planet Earth, not the United States, not NASA, not Ames."

In the meantime, the people of Earth can begin to learn from the Search for Extraterrestrial Intelligence. Bob Arnold, also a member of the Ames SETI team, thinks the search has great potential to capture the imagination of the people of the world.



This engraved image affixed to the two Pioneer spacecraft is leaving our solar system. The lines in the middle locate our sun from distant locations in the galaxy and icons on the bottom identify the source of the spacecraft. The man and woman are drawn to scale standing beside a replica of the Pioneers.

"...Forces you to think of the human race..."

"Here's a chance for the very young to learn what it's like to think scientifically, to develop a critical intellect. This can be extended in many other areas to get people to extend their minds. SETI is a force of reason in this world. Deep down, I hope it will promote greater reason in the human race because of the way it forces you to think of the human race from a cosmic perspective. This is the first step in solving some of the problems we have now."

However, Arnold cautions that this will have to "soak into minds over a series of generations. But it gives me a hopeful feeling that this is happening at this time. It's a great tribute to the United States. It sends a message to all other peoples of the world about the meaning of exploration. It's really a thrilling thing."

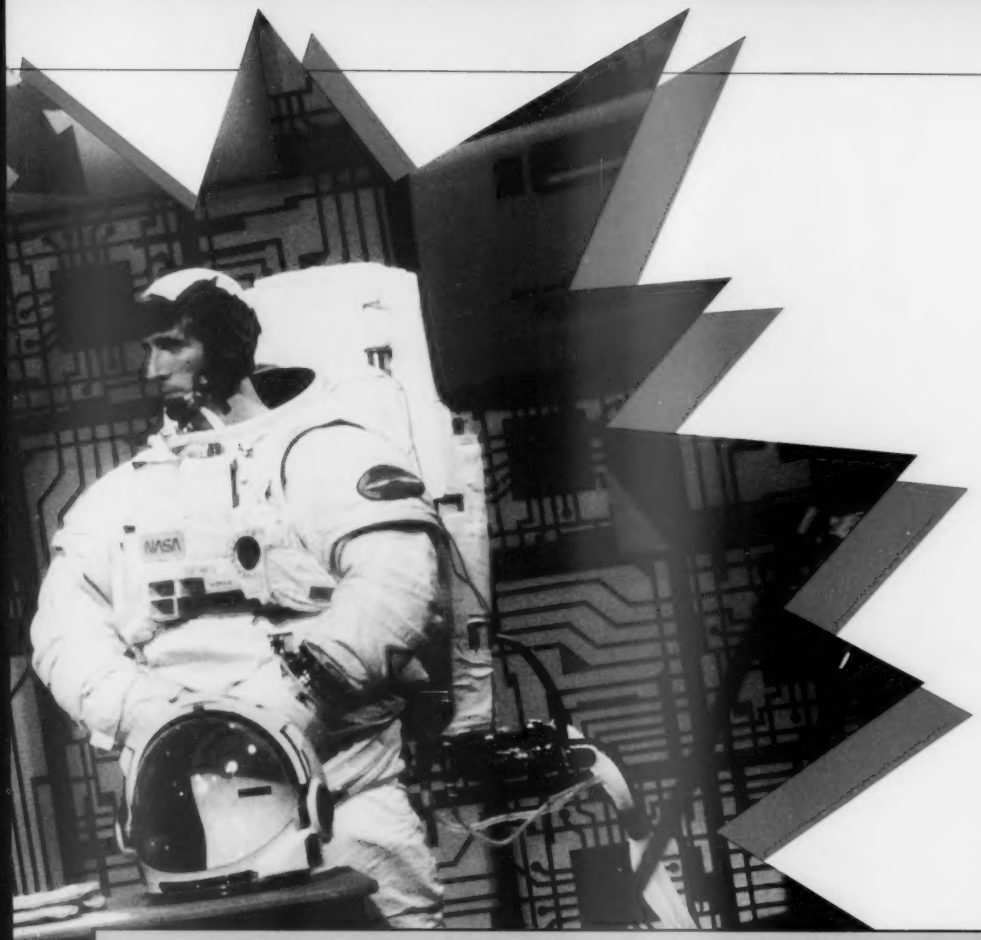
Arnold captures the feeling of all SETI pioneers, as well as the current Ames and JPL SETI teams, when he says, "I think we're at a critical juncture in the history of education in this country. We're trying to make young people think carefully about the direction of their lives. What is worth doing in their lives? Here's a chance to make a contribution to science."

The National Science Foundation agrees. It has funded the SETI Institute, now directed by Frank Drake, with a $700,000 grant (NASA has added in another $300,000 contribution) to use SETI as the foundation on which to build a supplemental science curriculum that should fire the intellects of young people around the nation.

On October 12, 1992, at 12:00 noon Eastern Standard Time (Earth time, that is), Jill Tarter, Ames SETI project scientist,will throw the switch at Arecibo, her deputy, Sam Gaucus, will at the same time throw the switch at Goldstone. They will simultaneously be setting fire to a lot of intellects and turning the dreams of Frank Drake, Philip Morrison, John Billingham, Bernard Oliver, Carl Sagan and many, many others into reality. After 33 years, the Search for Extraterrestrial Intelligence actually will be underway. ●

Charles Redmond has worked for NASA since 1973 when be began as a Skylab mission commentator at JSC. He has served as public affairs officer since coming to Headquarters in 1981.

LAUNCH
NICKELODEON
BOX



Your TV Connection to Outer Space

Math and science. Bo-or-rring, right?

Maybe not. There's a new way for kids to make the connection between those "boring" classroom subjects and the excitement of space exploration.

Yeah, right.

No, really. Nickelodeon—cable's network for kids—in cooperation with NASA and the Astronaut's Memorial Foundation, has a new show worth taking a look at: "Launch Box—Your TV Connection to Outer Space."

What's so exciting about that, dude?

Well, for one thing, the series of 14 half-hour programs, covering topics from "The Spectacular Space Suit" to "Living in Space" to "The Living Earth," was created by teachers especially for classroom use.

Gnarly! You mean I get to watch TV in class?

Yeah, if your teacher wants. As part of Nickelodeon's "Cable in the Classroom" programming, the show is broadcast at 6:30 a.m. Eastern time on Fridays, and is meant to be taped for use anytime.

So just what happens on this most excellent adventure?

You see 20 minutes of real NASA space missions and related activities, plus your teacher gets another 10 minutes' worth of background information and suggested classroom applications for Grades 3 to 8. This show makes math and science fun!

Kowabunga, man! So where's the pizza?

You gotta bring the pizza yourself, dude. ●

DAYS OF L

Most airplanes go out of their way to avoid thunderstorms.

"I KNEW WE WERE ICING UP WHEN WE STARTED LOSING OUR BASIC INSTRUMENTS. THE AIRSPEED INDICATOR WOULD FREEZE UP, THE ANGLE OF ATTACK PROBE WOULD FREEZE TO THE SIDE OF THE FUSELAGE AND THE PLANE WOULD START LOSING ALTITUDE. THAT MEANT IT WAS TIME TO GET OUT OF THE STORM..."

NASA research pilot Phil Brown

When the F-106B airplane prosaically dubbed "NASA 816" finally retired to the Virginia Air and Space Center in Hampton this year, it left behind hours of video and dozens of photos to document its long flight research career for the agency.

But sometimes a word can be worth a thousand pictures. You want to know the real story of what the plane did in its glory days? Ask the NASA pilots and flight engineers who wrenched the 17-ton beast through the skies over and around the Lewis and Langley Research Centers for almost a quarter-century, studying airflow, testing improved handling devices, and—most dramatic of all—seeing how lightning strikes affect an airplane in flight.

Earle Boyer and Cliff Crabbs got first crack at the two-seat '106 when it arrived at Lewis in 1966 after a nine-year stint with the Air Force. One of Boyer's first assignments was to take the plane on a series of airspeed calibration flights at Wright-Patterson Air Force Base near Dayton, Ohio:

"The aircraft was new to us and the program was something we hadn't done before. We made some of those runs at 600 knots (690 mph), just 50 feet off the ground. That's moving!"

Engineers wanted data on how airflow at transonic speeds might affect propulsion systems for future supersonic transports, so NASA modified the aircraft (then numbered "616") with two additional J-85 jet engines slung under its wings. Over the next 13 years, Boyer and Crabbs tested various combinations and exhaust nozzles on the extra engines, which one of the pilots controlled from the rear cockpit. Boyer recalls that the missions were relatively routine—or at least as routine as a supersonic flight can be.

In 1979 the aircraft got

Carol Petrachenko

Langley flight engineer Bruce Fisher (left) and research pilot Phil Brown braved thunderstorms in NASA's two-seater F-106.

I G H T N I N G

For seven years, NASA 816 flew into them.

by Les Dorr, Jr., Hq.

a new home at the Langley Research Center, and a new designation, "816." After extensive changes to "lightning-harden" the plane, it was to be flown first around— and then directly into—thunderstorm cells, in support of the aptly named Storm Hazards program. The goal: to get basic information about aircraft lightning strikes that designers would need to protect the digital electronics and composite structures planned for future airplanes.

Although he wasn't a pilot, Bruce Fisher was an aerospace engineer with a professional interest in lightning. He had specialized in flight research on atmospheric phenomena since joining NASA in 1970. His experience made him a natural back-seater for NASA 816's Storm Hazards work.

"As flight engineer, I was responsible for a dozen different data systems," says Fisher. "I also called out a running commentary on turbulence, rain rates, the lightning strikes, cloud entry and cloud exit. The researchers found that the oral observations were an excellent supplement to the raw digital data."

Except for the first few thunderstorm penetrations ("Nature might have had some really big surprises we hadn't accounted for"), Fisher was simply too busy to be apprehensive during a typical mission. The most important thing was "to make sure that you didn't waste all that time, money and effort by forgetting to do something critical."

Occasionally he would snatch a few fleeting seconds to drink in the magnificent beauty of his surroundings.

"I remember once there was a strong vertical shear as we blew out of a storm," Fisher says. "Bang! A hard jolt up. Then bang! A hard jolt down. I looked back, and I could see a sheer wall of clouds. Ahead, I could look forward for what seemed hundreds of miles."

Fisher's pilot on many lightning-hunter missions from 1982 on was Phil Brown, an ex-Navy jet jockey who had come to NASA eight years earlier. Brown was the consummate pro. He had flown 62 different NASA, military and civilian aircraft before volunteering for the Storm Hazards project.

"I navigated according to what showed on my radar screen and confirmed with the ground radar (at the Wallops Flight Facility) which storms were electrically active," Brown recalls. "But the cells could change

size, shape and intensity fairly rapidly. We'd pass through a storm, and by the time we turned around a minute and a half later, it would be hard to recognize."

Brown didn't have much trouble finding the right storms. The '106 was zapped by lightning more than 400 times during his flights. One mission was especially "productive:" The plane took 72 strikes!

Brown found that lightning could be capricious. Some hits were "very dramatic," others hardly noticeable. "On the most spectacular, the concussion was so powerful that the floorboards of the airplane rippled," he says matter-of-factly.

Some hits were "very dramatic," others hardly noticeable. "On the most spectacular, the concussion was so powerful that the floorboards of the airplane rippled."

When the storm research ended in 1986, Brown chose to take NASA 816 on to its next challenge. Langley technicians fitted the plane with a "vortex flap" on the leading edges of its delta wings to improve its handling qualities at subsonic and transonic speeds. Computer simulations and wind tunnel tests had shown that the flap should work. Brown had to prove the engineers' theories in flight.

"It turned out to be sensitive to nose-up and nose-down inputs," he says, "and it was a little squirrelly in tight turns. You had to use caution to avoid over-control."

The Vortex Flap program was NASA 816's finale. The plane's maintenance needs were higher and its performance lower than more modern aircraft the agency could use for flight research. Phil Brown is characteristically pragmatic about the decision to shelve the historic jet: "Its day is over. It's a '50s aircraft; we have to at least come up to the 1970s." His frequent seatmate Bruce Fisher is just glad that the airplane "won't end up being expended in air-to-air target practice."

But the NASA pilot who first flew the '106 on its aerial odysseys seems genuinely sorry to see it go. "You get kind of attached to it, and you're sad to lose that capability. But that's the way this business is," says Earle Boyer.

"A pilot is always glad to have flown that type of airplane," he adds. "It was a real thrill."●

Les Dorr, Jr., works in the Office of Aeronautics, Exploration and Technology for the Office of Public Affairs. He is a frequent contributor to NASA publications and has been published extensively elsewhere.

TAKE A LOOK AT THE NEW NASA SELECT

Kathryn Greenfield and Ann Sundius share anchoring duties on "NASA Today", seen Monday through Friday at noon, 4:00 p.m., 8:00 p.m., and midnight. The program focuses on the latest news in space and aeronautics, and activities at NASA centers and Headquarters, as well as news of general interest to NASA employees.

It's the closest thing to a "Space Channel" on TV. It's the "new" NASA Select, and if you haven't seen it lately, you will want to tune in.

The agency's in-house television service now offers an expanded schedule of programming, with shows focused on our exploration efforts, our aeronautical research, and even—in a special feature called "This Day in NASA History"—our past.

NASA Select comes on the air every Monday through Friday at noon Eastern time with "NASA Today," our own daily newscast, featuring close-up views of the latest goings-on at headquarters and at the agency's family of centers. That's followed at 2:00 p.m. by an educational program suitable for classroom use.

Each weekday's schedule runs in four-hour segments, four times a day, with billboarded information carried from 4:00 a.m. until noon. (Mission coverage and press events take precedence over regularly scheduled programs, so schedules are subject to change without prior notice.)

For more details, write NASA Select, c/o Headquarters, Code P, or call (202) 453-8425. •

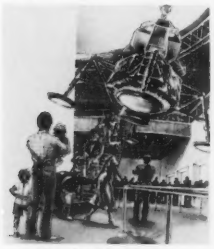
Spread the word! If your local cable system doesn't carry NASA Select, please share this information with them and encourage them to do so:

NASA Select is transmitted on
Satcom F2R Transponder 13,
C Band
72 Degrees West Longitude
Frequency: 3954.5 MHz
Vertical Polarization
Audio on 6.8 MHz

JOHNSON

Liftoff, Space Center Houston!

The sky's not the limit for NASA, and Johnson Space Center's new visitor complex, Space Center Houston, will send that message to the world.



The facility, now under construction, is expected to attract 2.3 million visitors in its first year and add about $100 million annually to the Houston-area economy. Grand opening for the 50-acre center is scheduled for the fall of 1992, reports General Manager Vance Ablott.

Visitors will experience computer-simulated shuttle flights, along with simulations of weightlessness and other hands-on activities, and will be able to see Moon rocks on display. The facility includes two theaters, one of which has a screen more than five stories tall that will tell the story of astronaut training. Visitors also will be able to take a guided tram tour of JSC and watch special programs in the lobby of Space Center Plaza.

The non-profit Manned Space Flight Education Foundation, Inc. was formed specifically to build the world-class visitor center at JSC. The $70 million center is financed primarily by tax-exempt bonds, with $10 million being contributed by the federal government. ●

KENNEDY

Runway Hospitality at KSC

With Florida palmetto now more likely than ever to greet astronauts returning from space, Kennedy Space Center is making sure that Shuttle landings are as hospitable as possible—not with red carpets and silver tea sets, but with improvements to the existing 15,000-foot Shuttle runway.

Over the years, deterioration of the runway's two 1,000-foot underruns and its 50-foot shoulders has softened them in some spots, causing potential hazards if a Shuttle were forced to use the safety margins. These areas will be restored and improved, and new edge lights and illuminated distance markers will be installed.

Work already has begun on the $4.35 million rehab project. Working around the Shuttle launch and landing schedule, the project is expected to be completed by next September. ●

AMES-DRYDEN

Blackbirds Fly High

Once the Air Force's premiere reconnaissance aircraft, and still the world's fastest and highest-flying production airplane, the SR-71 Blackbird is now back in the air, flying with the NASA logo on its tail.

Three SR-71s, on loan from the Air Force, are now on station at Ames-Dryden Flight Research Facility. One of the Blackbirds, a unique twin-cockpit "B" model, is being flown in training flights by NASA crews. The agency plans to use the planes—which can fly faster than three times the speed of sound and climb to altitudes higher than 85,000 feet—as testbeds for high-speed, high-altitude research in aerodynamics, propulsion, structures, thermal properties and instrumentation. Such research could help designers of future supersonic or hypersonic aircraft, including the National Aero-Space Plane.

The flight crew for the Blackbirds includes research pilots Stephen D. Ishmael and Rogers E. Smith, and flight engineers Robert E. Meyer and Marta Bohn-Meyer. ●

What On Earth?

The Earth from a unique perspective, a manned spacecraft in orbit. But what's going on below? Taken from Space Shuttle Columbia during STS-32, Saudi Arabia's Jabal Tuwayq region with its center-pivot irrigation systems uses abundant subsurface "fossil" water reserves for self-sufficiency in food production. This water infiltrated deep aquifers over the Central Arabian Arch during earlier, wetter geological periods. (Contributed by Kamlesh Lulla, JSC Flight Science Support Office.) ●

MARSHALL

Nothing Succeeds Like Success

Success of the Astro-1 mission has prompted NASA to do it again. Like Astro-1, flown in December 1990, Astro-2 will be dedicated to astrophysics studies. A group of Shuttle-borne instruments will observe energetic celestial objects in the ultraviolet region of the electromagnetic spectrum, which is possible only from space.

Instruments expected to fly onboard the second Astro mission in September 1994 include Johns Hopkins University's Hopkins Ultraviolet Telescope, Goddard Space Flight Center's Ultraviolet Imaging Telescope, and the University of Wisconsin's Wisconsin Ultraviolet Photopolarimeter Experiment.

The Hopkins telescope breaks light into its constituent colors, helping scientists to determine the chemical composition and temperature of target objects. The Ultraviolet Imaging telescope produces pictures of the hottest regions of nebulae, stars and galaxies to understand their structures. The Wisconsin instrument measures the polarization of light to help understand physical processes going on in distant regions of the universe.

Astro-2 will be managed by Marshall Space Flight Center for the Office of Space Science and Applications. ●

LANGLEY

If the Shoe Fits

A model of a lifting-body vehicle that holds eight passengers and two pilots is being used at Langley to evaluate human factors considerations. Such a vehicle is among the concepts being considered by NASA to supplement manned access to space, including flights to Space Station Freedom.

Thirty volunteers representing a full range of Space Station astronauts (from four feet, ten inches tall to six feet, three inches tall) are participating in the study, which involves body measurements, subjective acceptability, pilot viewing and emergency egress.

If developed, the HL-20 Personnel Launch System would be launched from an expendable booster, and would be capable of runway landings. The model used in the evaluations is 29 feet long and has a wingspan of more than 23 feet. ●

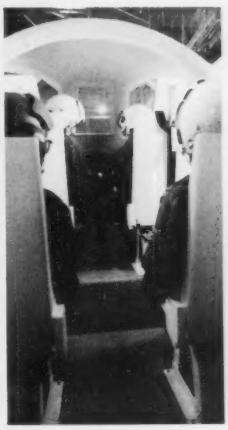
GODDARD-WALLOPS

Global Thermometer

Because knowledge of the amount of ice in polar glaciers could provide an indirect measure of difficult-to-assess sea level changes—and therefore global climate trends—Wallops Flight Facility researchers are measuring Greenland glacier elevations with highly precise airborne instruments.

Capable of measuring ice elevation to within four inches, repeated surveys with the Airborne Oceanographic Lidar could help determine changes in glacier ice volume over wide areas.

Using ground systems in Greenland is difficult because of the remote location, so Wallops' P-3 Orion and its airborne instruments offer a practical alternative, according to principal investigator Bill Krabill. ●



Inside the HL-20.

What hope remains when you've been beaten, abused, and abandoned? Terry Morris of the Langley Research Center found out from his own hard experience that education is the way out. "NASA's goal of reaching further and climbing higher," he says, "is characteristic of my own life."

Education Gave Me Self Esteem

by Terry Morris, LaRC

My life was very much like the bewildered life of a caterpillar, always roaming around the ground at the bottom, until I was metamorphosed through God and through education.

Abused by family members from an early age, I was the kid nobody wanted around. As punishment, I was forced to sleep outside in sub-zero temperatures—with one eye open to protect myself from roaming rats. I was beaten, then forced to drink large quantities of alcohol to ease my crying. I've been hit by cars and knifed through the hand. At fourteen, I was abandoned by my family near Tupelo, Mississippi. For six weeks I slept in derelict car bodies and buses. With little or no food to eat, no change of clothing, no family, no friends: I had only God.

Picked up by the police and tossed in jail, I was finally introduced to Alpha House in Tupelo, a group home for boys in need.

In Alpha House I gained the discipline and direction that had always been missing in my life. It was there that I learned the importance of education. And education gave me the self-confidence and self-esteem I needed. I soon realized that people could take away my home, my family, even the clothes on my back, but they couldn't take away my education. This led me to pursue my schooling with a passion, and I studied hard to make the grade.

Education teaches knowledge, and knowledge is power. But power by itself can be used in a variety of ways. I also learned about the love of fellow man, of caring for others. That allowed me to give knowledge, to share it with others. That love gave my knowledge direction and meaning.

In high school I applied myself in math and science classes, rounding out my education with arts, religion, phys-ed and vocational courses. Graduating from high school with highest honors, I began the first of six cooperative education work semesters at the Langley Research Center, studying the supersonic aerodynamic characteristics of wings. At summer's end, I started my first semester at Mississippi State University.

During the next five years, I alternated semesters between Langley and MSU. My co-op work at NASA helped pay the cost of attending the university. Though I graduated in May 1990 with my electrical engineering degree, the most important part of my education has been what I've learned through NASA. NASA has shown me that beyond Pluto is another planet called research. NASA's goal of reaching further and climbing higher is characteristic of my own life as a caterpillar.

I've learned another lesson, too. Once you reach your arm out into the universe to take hold of knowledge, you need to pull your arm back, open your hand wide, and share your knowledge with the world. Only through the giving of knowledge can the caterpillar become a butterfly. ●

Terry Morris is an electrical engineer in the Information Systems Division at the Langley Research Center. He recently served as a national spokesman for the Combined Federal Campaign.

UPCOMING LAUNCHES

DECEMBER

● Launch of STS-44 Atlantis on a ten day Department of Defense Mission with payloads including a DoD Support Program satellite. Crew for the mission include Frederick D. Gregory, Terence T. Henricks, F. Story Musgrave, Mario Runco, Jr., James S. Voss and Thomas J. Hennen.

● Launch of a Delta II carrying the Extreme Ultraviolet Explorer (EUVE), from the Eastern Space and Missile Center, Florida.

3
DECEMBER

Launch of an Atlas-E from Vandenberg AFB, California. A NOAA-I environmental satellite is the payload.

UPCOMING FLYBYS

29
OCTOBER

The Galileo spacecraft flies by the asteroid Gaspra on its journey to Jupiter. Data from the encounter will be recorded for later transmission back to Earth.

UPCOMING EVENTS

29
OCTOBER

NASA Administrator Richard H. Truly delivers the keynote address for Space Exploration '91 Conference in Houston.

3-5
DECEMBER

NASA, the Technology Utilization Foundation and "NASA Tech Briefs" magazine sponsor the Technology 2001 Conference in San Jose, California, showcasing new technologies from NASA, other federal agencies and their contractors.

IN OUR NEXT ISSUE:

The Year in Review and

Past and Future NASA Spinoffs

...the children in today's classrooms are tomorrow's engineers, scientists, and colonists on the Moon—and beyond...

Richard H. Truly